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NASA-13856 (March 2003)  
NATIONAL AERONAUTICS NASA - KSC  
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SECTION TABLE OF CONTENTS

DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13856

AIR SAMPLING DETECTION SYSTEMS

03/03

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS
- 1.4 GENERAL REQUIREMENTS
- 1.5 SYSTEM REQUIREMENTS
- 1.6 QUALITY ASSURANCE
- 1.7 SERVICES OF A CERTIFIED FIRE ALARM SPECIALIST

PART 2 PRODUCTS

- 2.1 DISPLAY CONTROL PANEL
- 2.2 DISPLAY CONTROL PANEL STATUS INDICATIONS
  - 2.2.1 Alarm Threshold
  - 2.2.2 Air Flow Status Indicators
- 2.3 DETECTOR STATUS INDICATORS
- 2.4 FRONT PANEL SWITCHES
- 2.5 DISPLAY CONTROL PANEL AND DETECTOR INTERFACE
  - 2.5.1 Alarm Level 1 (Alert)
  - 2.5.2 Alarm Level 2 (ACTION)
  - 2.5.3 Alarm Level 3 (Fire 1)
  - 2.5.4 Alarm Level 4 (Fire 2)
  - 2.5.5 Trouble Indications
- 2.6 DETECTOR ASSEMBLY
  - 2.6.1 Nuicance Alarm Avoidance
  - 2.6.2 Detector Head
  - 2.6.3 Light Source
  - 2.6.4 Detector Sensitivity
- 2.7 ASPIRATING FAN
- 2.8 AIR FLOW SENSORS
- 2.9 AIR SAMPLING NETWORK
  - 2.9.1 Labeling
  - 2.9.2 Piping Materials
  - 2.9.3 Design Layout

- 2.9.3.1 Zone Coverage
- 2.9.3.2 Sample Port Coverage Area
- 2.10 PRIMARY POWER SUPPLY
- 2.11 SECONDARY POWER SUPPLY
  - 2.11.2 Grounding
- 2.12 COMMUNICATION NETWORK

### PART 3 EXECUTION

- 3.1 SYSTEM SEQUENCE OF OPERATION
  - 3.1.1 Normal Operation
- 3.2 INSTALLATION
  - 3.2.1 Display Control Panel
  - 3.2.2 Smoke Detector
  - 3.2.3 Air Sampling Network
    - 3.2.3.1 Non-Metallic Tubing
  - 3.2.4 Spare Parts
  - 3.2.5 Wiring
  - 3.2.6 60-Hertz Power
  - 3.2.7 Installation In Cabinets and Boxes
  - 3.2.8 Conduit and Raceways
  - 3.2.9 Labeling
- 3.3 FIELD TESTING
  - 3.3.1 External System Wiring
  - 3.3.2 System Acceptance Testing
    - 3.3.2.1 Acceptance Criteria
    - 3.3.2.2 Suction Pressure Test
    - 3.3.2.3 Smoke Transport Time Test
    - 3.3.2.4 Deviations
    - 3.3.2.5 Sensitivity Verification Test
    - 3.3.2.6 Smoldering Smoke Test
- 3.4 ACCEPTANCE TEST DOCUMENTATION

-- End of Section Table of Contents --

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SECTION 13856

AIR SAMPLING DETECTION SYSTEMS  
03/03

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NOTE: Delete, revise, or add to the text in this  
section to cover project requirements. Notes are  
for designer information and will not appear in the  
final project specification.  
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This section covers air sampling detection systems.

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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent  
referenced:

ASTM INTERNATIONAL (ASTM)

ASTM F 402 (1993) Standard Practice for Safe Handling  
of Solvent Cements, Primers, and Cleaners

ASTM F 442 (1996) Standard Specification for  
Chlorinated Poly Vinyl Chloride (CPVC)  
Plastic Pipe

FM GLOBAL (FM)

FM P7825 (1997; Supple I, II & III) Approval Guide

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA TC 13 (1993) Electrical Nonmetallic Tubing (ENT)

NEMA TC 3 (1990) PVC Fittings for Use With Rigid PVC  
Conduit and Tubing

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101 (1997) Code for Safety to Life from Fire  
in Buildings and Structures

NFPA 318	(1995) Protection of Cleanrooms
NFPA 70	(1999) National Electrical Code
NFPA 72	(1996) National Fire Alarm Code
NFPA 75	(1995) Protection of Electronic Computer/Data Processing Equipment
NFPA 90A	(1996) Standard for the Installation of Air Conditioning Ventilating Systems

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES  
(NICET)

NICET PDM	(1989; 2nd Ed) Program Detail Manual
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UNDERWRITERS LABORATORIES (UL)

UL 1449	(1996) Transient Voltage Surge Suppressors
UL 497B	(1993; 2nd Ed) UL Standard for Safety Protectors for Data Communications and Fire Alarm Circuits
UL 651	(1995) UL Standard for Safety Schedule 40 and 80 Rigid PVC Conduit
UL FPD	(1998) Fire Protection Equipment Directory

## 1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification.

### SD-01 Preconstruction Submittals

Evidence of the Contractor's State Certification shall be submitted to the Contracting Officer for approval prior to any work being started on the Fire Alarm System.

Fully verified and dated copies of all test data and results shall be submitted with a copy of the approved test procedure and any factory test information.

The Contractor shall provide two copies of the test procedures and recording forms for the preliminary tests. For the final acceptance tests, the Contractor shall provide 10 copies of the test procedures and recording forms.

### SD-02 Shop Drawings

The following shall be submitted for air sampling detection systems in accordance with the paragraph entitled, "General Requirements," of this section.

#### Connection Drawings Schematics

As-Built drawings shall be submitted for approval 14 days prior to the acceptance testing phase of the project as described in the paragraph entitled, "Field Testing" of this specification section. Magnetic media and hard copies of all new and revised software and drawings shall be provided with the submittal. As-Built drawings shall document final system configuration including deviations from and amendments to the drawings, and field installation changes, concealed and visible.

Intergraph compatible (DWG Format) computer generated floor plan layouts indicating location of monitoring facility fire alarm control panel [preaction control panel], air sampling piping (lengths of pipe) and sampling ports (sizes and locations) shall be provided. Floor plan shall also indicate geographic monitor zone boundaries, location of display control panel and bar level annunciation panels if separate and all other associated equipment that is required to provide a complete operational system.

#### SD-03 Product Data

Manufacturer's catalog data and Display Control Panel shall be submitted for the following items:

- Detector Assembly
- Aspirating Fan
- Power Supply
- Filter
- Piping Materials
- Pipe Hangers and Supports
- Batteries and Charger
- Software and Programming
- Interface Equipment for Reporting and Monitoring

#### SD-05 Design Data

Design Analysis and Calculations shall be submitted for the Air Sampling Detection Systems consisting of the battery capacity, loading calculations, and air flow/transport calculations with schematic diagrams showing pipe segments, pipe diameters, lengths of pipe, node numbers, sample port diameters etc. to verify the requirements are met.

List of Parts and Components shall be submitted for air sampling detections systems in accordance with the paragraph entitled, "System Requirements," of this section.

List of parts and components for the installed system by manufacturer's name, part number, and nomenclature, and recommended stock level required for normal maintenance and unscheduled repairs.

#### SD-07 Certificates

Quality Assurance Plan shall be submitted consisting of the following:

Contractor shall prepare a test procedure and test record forms for conducting and recording complete tests on control panels, wiring systems, and air sampling piping networks installed in accordance with the manufacturer's requirements and these specifications. Contractor shall submit for approval the test procedure to the Contracting Officer at least 30 days prior to the preliminary system test described in the paragraph entitled "Field Testing" of this specification section. The test procedure shall identify each device, circuit, piping network, and sampling port to be tested, describe the initial condition, each step or function in the test, required test results annotating acceptable ranges and actual values, and submit manufacturer's specifications for all test equipment that will be used. Test forms with suitable spaces shall be provided for recording test results on all equipment, devices, wiring and sampling ports. The test record forms will also have identified spaces for verification signatures of official witnesses and dates of the tests.

Contractor shall submit proof that all components are currently Underwriter Laboratory (UL) listed UL FPD or Factory Mutual (FM) FM P7825 approved for their intended use and function.

#### SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted for air sampling detection systems in accordance with the paragraph entitle, "Installation," of this section.

### 1.4 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

Connection Drawings shall be submitted for approval for Air Sampling Smoke Detection Systems.

Connection Drawings shall consist of point-to-point wiring diagrams of internal and external wiring including, but not limited to, all smoke detection devices, and panel wiring. Point-to-point wiring is defined as wiring from device with integral terminal strip to next device with integral terminal strip, wiring between modules internal to control panels, circuit termination's on terminal strips in control panels, and terminal boxes with integral terminal strips.

Intergraph compatible (DWG Format) computer generated Connection Drawings shall be submitted.

Schematics shall be submitted for approval for each Air Sampling Smoke Detection Systems consisting of the following:

Module schematic drawings (minimum size 11 inches by 17 inches) to be provided prior to system acceptance testing.

Program logic and/or ladder logic diagrams that show interaction of system components.

#### 1.5 SYSTEM REQUIREMENTS

List of Parts and Components for the installed system by manufacturer's name, part number, and nomenclature, and recommended stock level required for normal maintenance and unscheduled repairs shall be submitted.

The air sampling detection system(s) shall be a VESDA LaserPlus or equal containing all of the equipment, devices, software and programming, and piping networks required for system operation in accordance with NFPA Codes and KSC requirements, including communication, interface equipment for reporting and monitoring to the Central Fire Monitoring Station (CFMS) via the facility fire alarm control panel (FACP), which monitors the Pre action Control Panel (PCP). The Air Sampling system(s) circuits shall be NFPA 72 Class A Style D initiating device circuits and NFPA 72 Class A Style 7 signaling line circuits. Initiating and signaling line circuits shall be 24 Vdc. System shall conform to all the applicable requirements of NFPA 70, NFPA 72, NFPA 75, NFPA 90A, NFPA 101, and NFPA 318.

Contractor shall provide all addition equipment, cabinets, conduit, and labor to meet the requirements and intent of this specification.

#### 1.6 QUALITY ASSURANCE

Equipment to be provided under this specification shall be that manufactured fire-alarm equipment which meets the requirements of the section entitled, "System Requirements." It shall be the latest standard design, and shall be listed by Underwriters' Laboratories or approved by Factory Mutual for it's intended use. All devices installed will function with the display control panel and not interfere with the operation of the control panel.

#### 1.7 SERVICES OF A CERTIFIED FIRE ALARM SPECIALIST

Services of a Certified Specialist thoroughly experienced in installation of Air sampling detection systems and fire alarm system work shall be provided on site to perform or directly supervise the installation, make all necessary adjustments, and perform all tests on the Air Sampling smoke detection system at the site.

The specialist shall be considered certified when the specialist holds a valid Fire Alarm System, Level III Certification from the National Institute for Certification in Engineering Technologies, or a valid Level

III Fire Alarm Engineering Technician Certification from the International Municipal Signal Association (IMSA) or is licensed by the State of Florida as a Fire Alarm Contractor I in accordance with Florida State Statute, Chapter 489, Part II.

Evidence of the Contractor's State Certification shall be submitted.

Certification of other recognized agencies with equivalent requirements will be considered. Evidence of the equivalent certification and the basis of certification shall be provided to the Contracting Officer and be approved by the Contracting Officer prior to any work being performed at Kennedy Space Center. Contractor submitted certification requirements shall be in accordance with NICET PDM.

## PART 2 PRODUCTS

### 2.1 DISPLAY CONTROL PANEL

The display control panel shall be offered in various configurations to control and monitor all operations of the detector assembly and aspiration system to suit particular applications. All power and communication for the air sampling smoke detection system shall be channeled and distributed from the display control panel including referencing and chart recording. All alarm lamps, trouble lamps, and alarm level threshold set-points, shall be visible on the panel face. All time delays, alarm level adjustments, and testing facilities for detector sensitivity shall be protected within a secured enclosure to prevent tampering. An override circuit per manufacturer's requirements shall provide fail-safe operation in the event that the programmed alarm threshold is not set or is disabled, the fourth alarm threshold automatically defaults to the full-scale smoke level. The display control panel shall maintain a smoke level history log and a historical event log. The storage capacity for the smoke level history shall be a minimum of 40,000 samples. The historical event log shall have a minimum storage capacity of 100 events. The display control panel shall be capable of retaining this information upon loss of both primary and secondary power sources.

For single zone or multiple zone applications a unitized, self-contained, single enclosure detector/display control panel may be utilized.

In multiple zone installations where it is desirable to have a central control point monitoring and controlling the remote detector assembly panels; a multi-zone display control panel shall be used. The display control panel shall be appropriately sized depending on the number of remote detectors used.

### 2.2 DISPLAY CONTROL PANEL STATUS INDICATIONS

The display control panel shall display the detector's continuous output of smoke levels per active zone; in a minimum 10 percent increments of full scale. Each controller shall include a bar graph display feature with bar graph indicators being light-emitting-diodes (LED) or liquid crystal displays (LCD).



### 2.2.1 Alarm Threshold

The display control panel shall be provided with a minimum of four (4) alarm threshold levels for each zone:

- Alarm Level 1 - ALERT
- Alarm Level 2 - ACTION
- Alarm Level 3 - FIRE 1
- Alarm Level 4 - FIRE 2

Programmed alarm thresholds shall be clearly visible on the face of the display control panel, and shall be adjustable through the full bar graph scale of the display control panel. The visual alarm level indicator shall illuminate and/or flash when the detector output signal reaches the programmed threshold level for the programmed time. The visual alarm indicators on the display control panel shall have circuitry arranged so that they must be manually reset through the display control panel reset feature. Alarm thresholds shall be programmed to the following values unless the results of the System Acceptance Tests, required by this specification, indicate a clear need to change them. In the event that such a need is indicated, the Contracting Officer shall be notified, and provided with complete documentation concerning the need to deviate from these values. The initial threshold levels shall be approved prior to the final acceptance test.

Alarm Level 1: ALERT shall be set at 0.01 percent obsc./foot

Alarm Level 2: ACTION shall be set at 0.05 percent obsc./foot  
millimeter

Alarm Level 3: FIRE 1 shall be set at 0.20 percent obsc./foot

Alarm Level 4: FIRE 2 shall be set at 1.5000 percent obsc./foot

The display control panel shall contain individual adjustable alarm time delay features for each of the alarm threshold levels. The range of adjustment shall be 0 to 60 seconds. The alarm threshold time delays shall be programmed to 30 seconds for alarm levels 1 and 2 , and 15 seconds for alarm level 3 and 4.

### 2.2.2 Air Flow Status Indicators

The display control panel shall receive signals from the detector air flow sensor and shall continuously display the status of the air flow through the detector. The display control panel shall indicate a trouble condition when the air flow through the detector is insufficient to permit proper operation of the detection system. The initial setting shall be set at the factory and the final setting shall be selected based on the system configuration to be 10 percent reduction in air flow through the detector assembly. The display control panel shall transmit a trouble signal to Central Fire Monitoring Station for KSC via the facility fire alarm system from the preaction control panel.

The air flow fault threshold setting(s) shall be adjustable by the

manufacturer's on site representative to meet site specific conditions. The air flow fault alarm signal shall have a programmable time delay with a range of 0 to 60 seconds for each zone. The air flow fault time delay shall be programmed to the following value unless the results of the system acceptance and commissioning tests, required in this specification, indicate a clear need to change them. In the event that such a need is indicated, the Contracting Officer shall be notified, and provided with complete documentation concerning the need to deviate from these values. The time delay shall be set at ten seconds.

## 2.3 DETECTOR STATUS INDICATORS

A separate detector lamp shall indicate normal operating status when the system is functioning as designed. Detector status shall indicate a fault upon the loss of power, an open circuit or an electrical/electronic problem within the detector's circuitry or external wiring and shall transmit a Trouble signal to the Central Fire Monitoring Station for KSC via the facility fire alarm system from the preaction control panel.

Detector fault indicator shall be provided for each zone. The detector fault indicator shall flash and a trouble relay or separate detector failure relay shall operate when there is a failure/problem within the detector's circuitry or external wiring. The detector fault indicator setting shall be per the manufacturer's recommendations.

A detector fault time delay shall be provided. The time delay shall be adjustable from 0 to 60 seconds for each detector failure indicator lamp/relay.

Initial setting not more than 10 seconds.

The air flow fault and detector fault relay outputs shall be connected/wired to cause a zone trouble and general trouble conditions to be annunciated at the preaction control panel and transmitted to the CFMS via the facility fire alarm system. These functions shall be split as two separate trouble indications.

## 2.4 FRONT PANEL SWITCHES

A Reset switch shall be provided for each zone. Any alarm/fault condition shall cause the indicator lamps to flash and remain in this state until reset. Provide a disable switch or a separate maintenance by-pass switch to isolate each detector for testing purposes.

A detector bar graph sensitivity test switch shall be provided for each zone and shall be capable of testing the sensitivity of the detector from the front of the control panel. Detector sensitivity testing shall be accomplished by pressing a switch on the control panel, and holding it until the bar graph indicates hundred 100 percent of full scale. Where remote sensitivity testing can be accomplished through data link to a remote computer or alarm panel, the display control panel shall incorporate logic to disable the remote test and return the detection system to normal operation after 60 seconds.

Detector fault test switch shall be provided for each zone. The test switch simulates a detector head fault condition and verifies the integrity of the communication link between the controller and the detector.

Activating the detector fault test switch shall cause the test relay to energize and the detector status indicator lamp to extinguish.

If the communication link between the controller and the detector is monitored automatically, a separate detector fault switch shall not be required.

## 2.5 DISPLAY CONTROL PANEL AND DETECTOR INTERFACE

Provide all contacts, hardware, conduit and wire, and power required for proper operation and interface between the Display Control Panel and the Air Sampling Detector Assembly. The display control panel shall have a minimum of three independently programmable ALARM LEVELS. The fourth Alarm Level when provided shall be programmed as Alert 2.

### 2.5.1 Alarm Level 1 (Alert)

Alarm level 1 (ALERT): The display control panel shall be configured and programmed so that when ALARM LEVEL 1 is reached for any detector, the alarm level lamp for that detector shall illuminate and an audible and a visual alarm shall sound at the display control panel. A SUPERVISORY ALARM shall be activated at the PCP and transmitted to the CFMS via the facility FACP.

### 2.5.2 Alarm Level 2 (ACTION)

Alarm level 2 (ACTION)): The display control panel shall be configured and programmed so that when ALARM LEVEL 2 is reached for any detector, the alarm level lamp for that detector shall illuminate and an audible and a visual alarm shall sound at the display control panel. A SUPERVISORY ALARM shall be activated at the PCP and transmitted to the CFMS via the facility FACP.

### 2.5.3 Alarm Level 3 (Fire 1)

Alarm level 3 (FIRE 1): The display control panel shall be configured and programmed so that when ALARM LEVEL 3 is reached for any detector, the alarm level lamp for that detector shall illuminate and an audible and a visual alarm shall sound at the display control panel. A SILENT ALARM shall be activated at the PCP and transmitted to the CFMS via the facility FACP.

### 2.5.4 Alarm Level 4 (Fire 2)

Alarm level 4 (FIRE 2): The display control panel shall be configured and programmed so that when ALARM LEVEL 4 is reached for any detector, the alarm level lamp for that detector shall illuminate and an audible and a visual alarm shall sound and at the display control panel. An ALARM shall be activated at the PCP and transmitted to the CFMS via the facility FACP.

#### 2.5.5 Trouble Indications

The air sampling control panel shall be set-up so in the event of an air flow fault, or a detector fault; the appropriate air flow fault lamp or detector fault lamp shall illuminate. The display control panel shall activate a TROUBLE ALARM at the PCP and transmit it to the CFMS via the facility FACP.

#### 2.6 DETECTOR ASSEMBLY

A single detector shall be of type tested and approved, for a maximum coverage of 20,000 square feet 2,000 square meter. The detector shall be usable in environments with relatively high levels of airborne dust and other contaminants through the use of a filter or other approved method.

##### 2.6.1 Nuicance Alarm Avoidance

Treatment of contaminants shall be by either an air filtration mechanism or by electronic discrimination of particle size. If a mechanical filtering system is used, a disposable filter cartridge shall be provided to permit visual inspection of the filter without having to dismantle the display control unit. The filter shall have a maximum nominal pore size of 20 microns per manufacturer's requirement.

##### 2.6.2 Detector Head

The detector head shall consist of inlet and outlet ports, quick connector type electrical receptacles for controller interfacing, a detection chamber with light source and optical components, and a signal processing electronic circuitry; all in a single assembly.

##### 2.6.3 Light Source

Air is drawn into the detector via the aspirating system, the air shall be exposed to the light source within the detection chamber. Light scattered by smoke particles within the air stream shall be converted to an electronic signal directly proportional to the obscuration level within the chamber. A signal corresponding to the obscuration level within the chamber shall then be transmitted to the display control panel.

##### 2.6.4 Detector Sensitivity

The manufacturer shall provide a minimum sensitivity range from 0.0015 to 7.0 percent obscuration per foot (obs/ft) 0.005 to 20.0 percent (obs/m). The manufacturer shall recommend the detector sensitivity for the area to be protected by zone. This detector sensitivity shall be approved by the contracting officer prior to installation of any equipment.

#### 2.7 ASPIRATING FAN

The aspirating fan shall be a high-efficiency, ball bearing, electric centrifugal-flow impeller pump designed for long life. The aspirator flow and pressure ratings shall ensure that the maximum transport time for an air sample removed from the furthest sample point of each branch within the

piping network shall not exceed 60 seconds.

## 2.8 AIR FLOW SENSORS

The detector shall be equipped with a sensing device(s) which will detect any change in the air flow through the detector which could impair the proper operation of the detector. The sensor(s) shall be wired to the control panel, and shall cause a TROUBLE condition to be initiated at the PCP and transmit it to the CFMS via the facility FACP.

## 2.9 AIR SAMPLING NETWORK

The air sampling network shall be a closed-end system, and shall be engineered for a maximum transport time of 60 seconds and have equal sensitivity throughout the entire system. The air sampling network shall be balanced so that the volume of air drawn from the last sampling point shall not be less than 60 percent of the volume from the first sampling point. Coverage of a single sampling pipe network shall not exceed 20,000 square feet 2,000 square meter. When the area to be protected exceeds the maximum square footage criteria, additional detectors shall be installed. Each sampling point (hole) shall have a maximum coverage of 900 square feet 84 square meter of floor area for above ceiling protection. Each underfloor sampling point shall have a maximum coverage of 400 square feet 37 square meter.

### 2.9.1 Labeling

All pipe and sampling points shall be labeled identifying "SMOKE DETECTION SAMPLING PIPE DO NOT DISTURB" and "AIR SAMPLING POINT" respectively.

### 2.9.2 Piping Materials

The sampling pipe shall consist of 1/2, 3/4, or 1 inch 13, 19 or 25 millimeter inside diameter material. Tubing and fittings as defined in this section, are limited to thermoplastic materials meeting or exceeding the requirements of PVC or an approved equal. Rigid Plastic Conduit PVC conduit shall be not lighter than Schedule 40. Rigid PVC shall be the slip-joint solvent-weld type and fittings shall be unthreaded solid PVC. Conduit and fittings shall be airtight and installation shall conform to NEMA TC 3, TC 13, NFPA 70 and UL 651. The color shall be white or gray. Directional changes in the piping network shall be accomplished by long radius bends. The use of standard elbow joints shall be approved by the Contracting Officer prior to installation. Final connection to the detector shall not be glued, but shall use a compression type fitting.

### 2.9.3 Design Layout

The air sampling network shall be designed and installed to monitor total room/zone concentration of smoke. The design shall be accomplished using a computer program which is based on sound fluid dynamic principles and is approved by Factory Mutual Engineering (FM) FM P7825 or listed by Underwriters Laboratories (UL) UL FPD for its intended use. This type of design requires that air samples be continuously drawn from the areas being protected.

#### 2.9.3.1 Zone Coverage

When the floor area to be protected exceeds 20,000 square feet 2,000 square meter multiple detectors shall be used. The maximum allowable coverage for any single detector shall not exceed 20,000 square feet 2,000 square meter.

#### 2.9.3.2 Sample Port Coverage Area

Each high level above floor sampling port shall have a maximum coverage of 900 square feet 83.6 square meter and underfloor area coverage shall not exceed 400 square feet 37 square meter. The sampling piping shall be installed above the suspended ceiling and supported from the building structure. The sampling point fitting(s) shall be centered in the ceiling tiles and connected to the main air sampling pipe using 3 to 6 feet 1 to 2 square meter lengths of 0.1875 to 0.25 inches 5 to 6 millimeter ID flexible tubing. The sampling port shall be sized as specified on the approved design drawings and confirmed by the computer generated design calculations.

#### 2.10 PRIMARY POWER SUPPLY

The normal power for the detectors and the display air sampling control panel shall be 120 volts AC, 60 hertz. All system components shall operate satisfactorily between 85 and 110 percent of normal voltage. The air sampling detection system disconnect/protective device shall be a fused switch with a red factory finish. This disconnect switch shall be mounted adjacent to the air sampling detection system. In addition, it shall be marked AIR SAMPLING DETECTION SYSTEM DISCONNECT with a label that is plastic or phenolic type red background with white lettering with a minimum of 0.25 inch 6 millimeter block lettering. The label shall be permanently affixed to the disconnect switch. Switch shall be capable of being locked in the "on" or "off" position. This feature shall not interfere with the circuit protection capability of the device. Switch shall be equipped with surge suppression for all phase and neutral conductors. Current limiting Class RK1 fuses properly sized to protect the Air Sampling detection system equipment shall be installed.

#### 2.11 SECONDARY POWER SUPPLY

Batteries and charger, and power transfer shall provide a means of automatically supplying the entire smoke detection system with battery backup power in the event the primary power system fails. The system shall switch to battery backup power in the event of AC power failure and switch back to AC power upon return of primary power. The air sampling control panel shall operate if the backup batteries are removed for any reason. The system shall control charging and floating level to maintain batteries in optimum condition. Capability to recharge batteries in event of discharge shall be provided. Wiring shall be fused to protect against battery over-current and polarity reversal. Primary power, battery, or charging equipment failure shall result in a trouble signal and visual indication at the display control panel, transmitted to the PCP and then to the CFMS via the facility FACP.

Battery modules shall be sealed (no corrosive fumes) and spill proof. Batteries shall be listed for fire alarm service and shall be suitable for high discharge currents required under alarm conditions. Batteries shall be sized to operate the Air Sampling smoke detection system in normal supervisory condition for 24 hours, minimum , then operate the system in the alarm mode for 10 minutes, minimum.

Provide a battery disconnect switch with dc rated contacts to allow testing for loss of secondary power supply.

#### 2.11.2 Grounding

The design of equipment will allow for low-impedance bond to the protective grounding system. Equipment must function in an environment which supplies only a safety ground per local electrical code requirements. Cabinet and equipment ground must be isolated from battery return at the equipment and within the frame or cabinet.

#### 2.12 COMMUNICATION NETWORK

The network shall utilize RS 232 or RS 485 using type TFN for No. 18 or No. 16 AWG twisted shielded pair cable for digital communication. Unauthorized access shall be achieved by utilizing a minimum of two levels of password protection. Computer access shall be achieved via an RJ 11 six conductor receptacle.

### PART 3 EXECUTION

#### 3.1 SYSTEM SEQUENCE OF OPERATION

##### 3.1.1 Normal Operation

The display control panel shall consist of an enclosure assembly, installation kit, and required number of display control cards, 1 to 4 zones as required and shown on drawings. Each display control panel shall be powered from a 24 VDC source and monitored for alarm and trouble conditions by the preaction control panel. The display control panel shall have the following light indications:

Bar Graph Display	Alarm Level Lights
Air Flow Fault Light	Detector Fail Light
CPU Fail Light	Normal Operation Indicator
Power Supply Light	Isolate Light
Trouble Light	

Normal operation, air from the protected zone is drawn through a piping network to the detector unit by an aspirating fan in the detector assembly.

The air is then illuminated by a light source. Smoke particles scatter this light to a sensitive, solid-state photo sensor. An analog signal is transmitted to the display control panel which displays smoke obscuration levels on a bar graph display. Each increment on the bar graph represents a percentage of the full scale sensitivity of the detector. Independently programmable alarm points provide additional visual indication on the display control panel and activate associated relays for additional

annunciation and alarm.

### 3.2 INSTALLATION

Operation and Maintenance Manuals shall be submitted for Air Sampling Detection Systems.

Information bound in manual format and grouped by technical sections consisting of manufacturer's standard brochures, schematics, procedures, recommended spare parts, recommended test equipment, and safety precautions. This information shall be submitted prior to any acceptance tests being performed.

#### 3.2.1 Display Control Panel

Equipment shall be installed in each protected area, located where indicated on the approved drawings, and shall be complete with all indicated accessories and devices. Equipment shall be installed in accessible locations in such a manner as to prevent damage from vibration or jarring. Equipment requires a minimum of three (3) foot 1 meter clearance directly in front of the display control panel and the detector unit for maintenance per NFPA 70. With multiple equipment, the three (3) foot clearance is required directly in front of the complete configuration.

In addition, a 28 inch [**NEED METRIC**] clear aisle way will be provided for access to the equipment. Cabinets shall be provided with a pin-tumbler cylinder lock (Lock Cylinder No. Best Universal Lock Co. No. A8817-XUS26D-7KSC) with removable core that will accept the key presently in use standardized key currently in use with all other fire alarm control panels at KSC; lock core will be provided by the government.

#### 3.2.2 Smoke Detector

The smoke detector shall be securely mounted to the building structure (i.e. ,column, permanent wall) using approved type anchors. The mounted detector's orientation shall be determined by the piping layout and application; while maintaining total access for servicing with a minimum clearance of 3 feet 1 meter directly in front of the detector. Mounting of the detector to cable trays, movable walls and other equipment or frames shall be approved by the Contracting Officer prior to installation.

#### 3.2.3 Air Sampling Network

The smoke detection system shall be supplied with an air sampling network for air/smoke transport to the detector from the protected area. The piping network shall be designed using a FM approved or UL listed air sampling system computer modeling program for design calculations. The air sampling network shall consist of a balanced piping system including main branch piping with sampling points (holes) at pre-determined locations with end caps. All piping network supports shall be from the building structure only. Alternate means of support as from cable trays, raceways, duct work, etc. shall be approved by the Contracting Officer prior to installation. All piping which is adjacent to the detector shall be mounted tight against the wall or other structural elements which the detector is mounted on, and shall terminate within 18 inches 457 meter of



the detector inlet ports. The air sampling piping shall be connected to the detector by a union with an 18 inch 457 meter PVC nipple of the same ID as the air sampling network piping, to facilitate maintenance. Optional open or closed end system, per manufacturer's approved computer modeling design program may be used. Main piping runs shall not exceed 300 feet 91.5 meter. All fire rated penetrations of floors, ceilings and walls, shall be sealed per local building code requirement except that no silicone containing materials may be used. The air sampling tubing shall be cleaned inside and out, and joined using manufacturer's approved methods and materials for air-tight connections except at the detector enclosure connections for servicing. Sampling ports shall be located so that they are clear of all supply air registers and/or air flows.

#### 3.2.3.1 Non-Metallic Tubing

Refer to ASTM F 402 for safe handling of solvent cements, primers and cleaners used for joining thermoplastic pipe and fittings. All piping shall be supported at approximately 5 foot 1.5 meter maximum intervals on center with bracing for end of pipe run not to exceed 1 foot .31 meter. Pipe hangers and supports and fasteners must be of appropriate dimensional size for supporting tubing without distortion. Refer to construction documents for additional and/or special attachment details. Conduit and fittings shall be airtight and installation shall conform to NEMA TC 3, NEMA TC 13, NFPA 70, UL 651 and ASTM F 442.

#### 3.2.4 Spare Parts

Spare parts shall be directly interchangeable with the corresponding components of the installed system. Spare parts shall be suitably packaged and identified by nameplate, stamping, or tagging. Furnish the following:

- a. One (1) air sampling smoke detector (sensitivity to match installed unit).
- b. One (1) control card, one (1) power supply, and one (1) aspirator/fan.
- c. Four (4) filter assemblies

#### 3.2.5 Wiring

Wiring shall conform to the requirements of NFPA 70 and NFPA 72 and the following special requirements:

Air sampling system circuits shall be installed in a separate raceway or conduit system. Within the air sampling system, 60-hertz power circuits and air sampling initiating and signaling line circuits shall be installed in separate raceway or conduit systems. 60-hertz power circuits shall not enter enclosures containing 24 Vdc air sampling system circuits except where required to connect to the air sampling system.

Conductors shall be continuous from a terminal point at the detector to a terminal point at the display control panel. Break wires at each

terminal; wires shall not be looped over a terminal. Solderless ring tongue terminal lugs shall be installed with manufacturer's required tooling on the device wiring connection leads. This ring type lug will be used on stranded wire only. Termination of solid wire conductors shall be made on compression or screw type terminals. When screw type terminals are used the conductor must be captured under 80 percent of the screw head surface.

Conductors shall be solid copper with an insulation rating of not less than 300 volts. Conductors shall be marked with the AWG size, voltage rating and manufacturer's name permanently marked on the conductor jacket at no less than 2 feet .70 meter intervals. Conductor size and color are listed below. Where modifications are made to existing systems, the new or added conductors shall match the size and color coding of the existing system.

Conductors for network communication circuits shall be solid copper, shielded, twisted pairs. Conductor size shall be as indicated but not less than No. 16 AWG diameter for signaling circuits. Cables shall be marked with circuit designation and consistent color coding for the positive and negative loops shall be maintained throughout the cable system. Cable shall be listed as type FPL, Power-Limited Fire Protective Signaling Cable.

Direct current initiating detector circuits shall be a two loop circuit per NFPA 72, Style D with the positive loop conductor colored blue and the negative loop conductor colored black. Conductors size shall be as indicated, but not less than No. 16 AWG. Conductor insulation shall be type TFN for No. 16 AWG and type THHN/THWN for No. 14 AWG and larger.

#### 3.2.6 60-Hertz Power

60-hertz power to the display control panel shall be 120 volts. There shall be one black phase conductor, one white solidly grounded neutral conductor and one green equipment grounding conductor. Conductor size shall be as shown on the drawing with the minimum size No. 12 AWG copper. Surge arresters shall be installed in accordance with NFPA 70, UL 497B and UL 1449.

#### 3.2.7 Installation In Cabinets and Boxes

Wiring in control cabinets and boxes shall be installed in a neat and orderly manner with wire properly grouped, tie-wrapped, or laced parallel and perpendicular to the major axis, supported and identified. Control wiring shall be continuous from device to device with no splices [unless otherwise indicated]. All wires entering or leaving control cabinets, boxes, and devices shall be permanently marked and terminated on screw terminals. Marking shall be consistent throughout the Air Sampling smoke detection system and shall be the same as the identification shown on the connection drawings.

#### 3.2.8 Conduit and Raceways

Minimum size for fire alarm system initiating, alarm and control circuit conduit and raceways shall be 3/4-inch 19 millimeter minimum. Installation

shall be in accordance with NFPA 70.

Rigid galvanized heavy wall steel conduit shall be installed in all hazardous (classified) locations, exterior above grade, interior exposed, from floor to five feet above finished floor unless shown on the drawings. EMT with hexnut expansion gland-type fittings may be installed in all other areas. Flexible metal conduit, maximum length 6 feet 2 meters, shall be used as the final connecting raceway to a air sampling system mounted on vibrating equipment or on a suspended ceiling.

Conduit in interior finished areas shall be concealed. Conduit penetrating fire-rated construction i.e., walls, floors, ceilings, roofs, etc. shall be fire-stopped with a UL listed or FM approved material commensurate with the fire resistance rating of the structure penetrated.

Conduit installed in a vertical position shall be parallel with walls and perpendicular with the floor and ceiling. Conduit installed in a horizontal position shall be parallel with the floor and ceiling and be parallel and perpendicular with the walls. Changes in direction of runs shall be made with symmetrical bends. Bends of over one inch in diameter shall be factory made elbows.

#### 3.2.9 Labeling

Provide at the smoke detector labels that are plastic or phenolic type red background with white lettering with a minimum of 0.25 inch 6 millimeter block lettering to indicate detector and zone. Example: "AIR SAMPLING SMOKE DETECTOR #1-1 ZONE #5"

Provide at the display control panel labels that are plastic or phenolic type red background with white lettering with a minimum of 0.25 inch 6 millimeter block lettering to indicate the controller, the detectors controller served, and location example: "AIR SAMPLING SMOKE DETECTOR CONTROLLER #1 - SERVES DETECTOR #1-1 ROOM ###, DETECTOR #1-2 ROOM ###, DETECTOR #1-3 ROOM ###, DETECTOR #1-4 ROOM ###".

The pipe network shall be clearly labeled every 5 feet 1.5 meter in open room areas, and within ceiling cavity; and every 2 feet .61 meter, centered in the floor panels, within the raised floor cavity. This is to distinguish the pipe from other facility pipe work or protective cabling enclosures. The labeling shall read: "SMOKE DETECTION SAMPLING PIPE. DO NOT DISTURB".

Every air sampling point shall be labeled with a round red label with a center hole to match the diameter of the drilled sampling point; and shall read: "AIR SAMPLING POINT DIA 0.XXXX INCHES#.# MILLIMETERS". Fractional dimensions shall be in decimal format indicating a minimum of four decimal places.

All electrical junction boxes and covers shall be painted "red", and labeled with a plastic or phenolic label, red background with white lettering with block lettering sized as needed to read: "AIR SAMPLING SMOKE DETECTOR SYSTEM".

### 3.3 FIELD TESTING

After complete installation of the equipment and at such time as directed by the Contracting Officer, tests shall be conducted to demonstrate that the installation requirements of this specification have been met and that the sequential functions of the system comply with the requirements specified herein. The tests covered in the following paragraphs shall be done in two parts:

- a. Preliminary - This will be an "in house" test to verify all the system(s) and components function in accordance with the approved contract drawings and specifications. This functional test shall be performed in the presence of government inspectors and shall be repeated until the Contractor can perform one full test without device or system malfunction.
- b. Final Acceptance - After the successful completion of the preliminary testing, the system(s) shall be fully tested formally with full documentation (including As-Built Drawings) using the previously approved recording form. The Contracting Officer will witness this test and final acceptance of the system will be based upon his written approval of the test. On both preliminary and final tests, the approved testing procedures shall be followed.

#### 3.3.1 External System Wiring

The following tests shall be performed on the external system wiring before connection to the control panel: Continuity of circuits shall be checked with an ohmmeter. Temporary jumpers shall be inserted in appropriate sockets of missing detectors and the end-of-line resistor shall be installed when this test is performed. Resistance reading for each circuit shall be the value of the end-of -line resistor, plus or minus 10 percent. Each wire shall be checked for grounds with a 500-volt insulation resistance test set. Resistance to ground shall not be less than 20 megohms. All tests shall be witnessed by the Contracting Officer or designee.

#### 3.3.2 System Acceptance Testing

Each zone of every system shall be subjected to a full operational test, in the presence of the contracting officer which must be successfully passed before any system shall be considered acceptable. The approved operational test procedure submitted by the subcontractor for the air sampling system and display control panel shall include the following tests:

##### 3.3.2.1 Acceptance Criteria

Acceptance criteria for air sampling piping network(s) and detector(s) shall include the following measurements and tests for each detector and it's air sampling piping network.

##### 3.3.2.2 Suction Pressure Test

Pressure at all sampling ports shall be measured, recorded, and compared to

APPROVED Design Calculations. The Suction Pressure shall be within the manufacturer's specified range and be measured in inches of water or pascals. Measured Suction Pressure shall not differ from the pressure calculated in the APPROVED Design Calculations by more than 10 percent.

#### 3.3.2.3 Smoke Transport Time Test

The time required for smoke to travel from the most remote sampling port in each air sampling piping network to the detector shall be measured, recorded, and compared to APPROVED Design Calculations. This TIME shall be determined on each branch line individually by introducing a "gross" smoke source into the sampling port which is hydraulically most remote from the detector. The TIME from the beginning of smoke introduction until the bar-graph on the display control panel reflects the presence of smoke in the detector is the Transport Time. The MAXIMUM ALLOWABLE Transport Time is 60 seconds. In addition to this requirement, the measured Transport Time shall not differ from the Transport Time calculated in the APPROVED Design Calculations by more than ten percent.

#### 3.3.2.4 Deviations

If any of the measured and recorded results differ from the measurement predicted by the APPROVED Design Calculations by more than ten percent, the cause of deviation shall be determined and corrected. If the cause is a difference between the system as built and the system as designed, revised shop drawings and calculations may be resubmitted for approval to the contracting officer. If the revised drawings and calculations agree with measured results within the specified ten percent, the system shall be considered acceptable provided that all other provisions of this specification have been met. No system shall be considered acceptable until the measured results agree with the values predicted by the APPROVED Design Calculations, within the 10 percent tolerance specified herein.

#### 3.3.2.5 Sensitivity Verification Test

This test is a month long (30 day minimum) test for all detection system installations. Each air sampling piping network by zone shall be subjected to this test before the system is considered acceptable. The purpose of this test is to ensure that the earliest possible alarm for smoke is rendered with the fewest number of false alarms; this shall be considered mandatory. Due to the fact that the ambient levels of dust or other air borne particulate which the detector may sense as smoke varies from building to building or room to room within a given building or area.

- a. Proper test procedures and data analysis should eliminate all false alarms from transient dust or smoke which may become airborne due to installation activity, cleaning and/or normal operations.
- b. During the period while the sensitivity verification test is being conducted, normal operations shall continue unaltered within the area being protected. The preaction control panel (PCP) shall monitor the air sampling detection system and the facility panel shall monitor the PCP. The PCP shall only transmit supervisory

and trouble conditions to the CFMS. During this trial period the air sampling detection system shall not activate any automatic suppression systems or cause a facility evacuation.

- c. After the air sampling detection system has been installed and all acceptance tests successfully conducted, the event log and the smoke level history log shall be maintained for a period of not less than 30 calendar days.
- d. Data review and analysis should be conducted after 7 calendar days of operation to identify any gross trends, and again at the end of 30 calendar days of operation. Additional interim analysis maybe required depending on the results of the first week review.
- e. Data review and analysis shall consider the normal base line, or ambient, pollutant level recorded, and all deviations from the established base line as recorded by the data logger from the display control panel.

The level of the ambient base line shall be compared with the alarm threshold levels selected. The minimum acceptable range between the ambient base line and the first alarm threshold shall be minimum twenty percent of the detector's full scale sensitivity calibration setting.

Each peak recorded shall be investigated to determine its cause. Analysis shall consider whether the peak recurrence is at regular intervals, or whether it is a single event. Recurring peaks are usually related to activities within the protected area. Non-recurring peaks are generally the results of other types of activities, including fires. Consideration of normal activity within the fire zone, the time of day, and day of the week may be of assistance in determining the cause of a peak.

The magnitude and duration of the recorded peaks shall be compared to the alarm threshold levels selected and initial time delay settings to determine if a false alarm would have occurred.

Based on the data review, adjustments will be made to alarm levels and time delay settings, as required to eliminate false alarms.

Peaks or alarms that are attributed to smoking in the protected area ARE NOT considered to be false alarms. The air sampling detection systems shall be configured specifically to alarm when smoking takes place within the protected area.

If data indicates that the adjustments to the alarm threshold levels and the time delay settings will not eliminate false alarms the detector sensitivity shall be changed. If the false alarms can not be eliminated alternative solutions shall be provided by the contractor to the Contracting Officer for approval and implementation.

Any change to the initial settings as prescribed by this specification

shall be fully documented with supportive analysis and review data and submitted by the manufacturer's to the contracting officer for approval.

#### 3.3.2.6 Smoldering Smoke Test

This test is a mandatory requirement used to establish the acceptance of the air sampling detection system. The contractor shall include in the test procedure a method similar to the wire overheat test using a set length of wire and a variac transformer to apply 120 VAC for a duration of 3 minutes, or use a predetermined length of wire coiled and laid on tin foil on a hot plate set at 700 - 900 degrees F \_371 TO 482\_degrees C for 1 to 3 minutes to ensure that the installed system(s) performance complies with the approved contract drawings and specifications. The test shall be carried out in the vicinity of possible fires (example: at equipment heights 3 to 5 feet 1 to 1.5 meter above the finished floor and under the raised floor). The test shall be repeated in different locations within each protected zone under normal and abnormal operating conditions of the HVAC system. This will ensure that the smoke source in both a high and still air flow environment have been addressed.

#### 3.4 ACCEPTANCE TEST DOCUMENTATION

The results of the acceptance testing shall be recorded by the installer. At least six copies of the completed documentation shall be submitted to the Contracting Officer.

-- End of Section --